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Implications of the new WHO guidelines on HIV and infant feeding for child survival in South Africa

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Introduction

In April 2010 the South African Department of Health and the National AIDS Council released revised clinical guidelines for the prevention of mother-to-child transmission of HIV (PMTCT).¹ These revised guidelines contain many promising changes including: highly active antiretroviral therapy (HAART) for all HIV-infected pregnant women with CD4 counts of ≤ 350 cells/ μ l; 6 weeks of antiretroviral (ARV) prophylaxis with nevirapine for all HIV-exposed infants; continued infant nevirapine prophylaxis until 1 week after complete cessation of breastfeeding for HIV-exposed breastfed infants whose mothers are not on HAART; and HAART for all confirmed HIV-positive infants from as early as 6 weeks of age. These changes provide the opportunity for South Africa to get back on track towards meeting the United Nations Millennium Development Goals 4, 5 and 6 through significant reductions in HIV transmission and mortality.

While these new guidelines are to be welcomed, one aspect is somewhat disappointing. This concerns the issue of infant feeding in the PMTCT programme. The new guidelines recommend the continued provision of free formula milk through public health facilities for women opting not to breastfeed (Box 1). This policy comes 5 months after the World Health Organization's (WHO) revised principles and recommendations for HIV and

infant feeding were released in November 2009.² A key WHO recommendation is that national or subnational health authorities estimate which feeding strategy is likely to provide the greatest chance of HIV-free survival for infants based on several factors, including background levels of infant mortality and the leading causes of infant mortality. Authorities should then decide whether health services should mainly counsel and support HIV-infected mothers to breastfeed and receive ARVs, or instead avoid all breastfeeding.

Box 1. Infant feeding recommendations in the 2010 South African clinical guidelines on prevention of mother-to-child HIV transmission¹

For all mothers:

- Counselling on infant feeding must commence after the first post-test counselling session in pregnancy.
- Infant feeding should be discussed with women at every antenatal visit.
- Mixed feeding during the first 6 months of life should be strongly discouraged as it increases the risk of childhood infections.
- Provide nutritional support for ALL breastfeeding HIV-positive mothers and for formula-feeding mothers with food insecurity.

Breastfeeding HIV-positive women:

- All mothers who are known to be HIV-infected either on lifelong ART or not, who exclusively breastfeed their infants should do so for 6 months, introduce appropriate complementary foods thereafter and continue breastfeeding for the first 12 months of life.
- Trained health-care personnel should provide high quality, unambiguous and unbiased information about risks of HIV transmission through breastfeeding, ART prophylaxis to reduce this risk, and risks of replacement feeding.
- Mothers who are known to be HIV-infected, and not on lifelong ART, who decide to stop breastfeeding at any time should do so gradually during one month while the baby continues to receive daily NVP and should continue for one week after all breastfeeding has stopped.

Formula feeding HIV-positive women:

- Free commercial infant formula will be provided to infants for at least 6 months.
- Women should receive practical support, including demonstrations on how to safely prepare formula and feed the infant.
- At 6 months of age, infants with – or at risk of – poor growth should be referred for continued nutritional monitoring and dietary assistance.
- An appropriate formula milk product for the infant's age and circumstances should be chosen.
- In cases in which commercial formula is provided free of charge at health facilities, managers, supervisors and health care personnel should ensure an uninterrupted supply at clinic level. A reliable procurement and distribution system should be put in place.

WHO's recommendations are based on accumulated programmatic evidence and research conducted over the past few years in African countries. In keeping with these recommendations, the new South African PMTCT guidelines state that the programme adopt an approach to infant feeding that maximizes child survival and not only the avoidance of HIV transmission. However, it appears that no determination has been made about which feeding practice will maximize HIV-free survival nationally. A choice between two feeding options (exclusive breastfeeding or exclusive formula feeding with free formula milk) is still recommended. The continued provision of free commercial infant formula is an incentive that can cloud feeding decisions. Research from South Africa³ has already shown that women are opting for feeding despite not meeting WHO AFASS (acceptable, feasible, affordable, sustainable and safe) conditions.

This paper presents the latest evidence regarding mortality and morbidity associated with feeding practices in the context of HIV infection and highlights the lack of a clear infant feeding policy for South Africa in the context of changing evidence. It questions the ongoing provision of free formula milk through the public health system and recommends a change in policy that prioritizes child survival for all South African children.

Benefits of breastfeeding

The single most effective intervention to save the lives of millions of young children in developing countries is the promotion of exclusive breastfeeding.⁴ Approximately 1.3 million child deaths per year (13% of deaths of children aged less than 5 years) could be prevented if universal coverage of exclusive breastfeeding were increased to 90% among infants aged less than 6 months.⁴ Compared with the use of breast-milk substitutes, breastfeeding has been consistently shown to reduce infant morbidity and mortality associated with infectious diseases in both resource-rich and resource-poor settings, particularly in the first months of life. The Bellagio Child Survival Group summarizing accumulated international research evidence states: "Infants aged 0–5 months who are not breastfed have seven-fold and five-fold increased risks of death from diarrhoea and pneumonia respectively, compared with infants who are exclusively breastfed. At the same age, non-exclusive rather than exclusive breastfeeding results in a more than two-fold increased risk of dying from diarrhoea and pneumonia."⁵ Recent estimates of proportional causes of under-5 mortality in South Africa put diarrhoea and pneumonia third and fourth respectively – behind HIV/AIDS and neonatal causes.⁶ Moreover, most deaths of HIV-infected children are due to supervening infections, most commonly diarrhoea and pneumonia.

Formula feeding

Over the past several years, evidence has been accumulating from Africa on the increased mortality associated with formula feeding in various PMTCT research studies. The MASHI study in Botswana⁷ was a randomized controlled trial that compared the efficacy of exclusive

breastfeeding combined with a course of 6 months of infant zidovudine (ZDV) prophylaxis versus formula feeding combined with 1 month of infant ZDV. Cumulative HIV transmission rates at 7 months were 5.6% in the formula-fed group and 9.0% in the breastfed plus ZDV group. The cumulative incidence of infant death by month 7 was significantly higher in the formula-fed group than in the breastfed plus ZDV group (9.3% versus 4.9%; $P = 0.003$). This supports earlier findings from Kenya of increased early mortality among formula-fed infants.^{8,9} However, in the MASHI study, by 18 months there were no significant differences between the formula-fed and breastfed plus ZDV group in the combined outcome of HIV infection or mortality (13.9% versus 15.1%; $P = 0.60$). Both strategies therefore resulted in comparable HIV-free survival at 18 months.

Evidence of the dangers of formula feeding in non-research settings have also been documented in Botswana. Between November 2005 and February 2006 there were unusually heavy rains and flooding which led to an increase in infant diarrhoea incidence and mortality. The United States Centers for Disease Control and Prevention was brought in to investigate the outbreak. It found widespread contamination of the public water supply in four northern districts of the country. The most significant risk factor for diarrhoea was not breastfeeding (adjusted odds ratio, AOR: 50; 95% confidence interval, CI: 4.5–100). Most of the deaths were among HIV-exposed infants whose mothers were receiving free formula milk through the PMTCT programme. Among hospitalized infants, 51% had poor growth before the illness.¹⁰ Recent evidence from Malawi has also found that not being breast-fed was significantly associated with declines in nutritional status as evidenced by decreased mean length-for-age, weight-for-age and weight-for-length z-scores.¹¹

In South Africa, research from routine PMTCT sites has found that an inappropriate choice to formula feed (without WHO AFASS conditions being met) carries a greater risk of HIV transmission or death than breastfeeding.³ In another study from the predominantly rural district of Hlabisa, Kwa-Zulu Natal, South Africa, cumulative 3-month mortality in exclusively breastfed infants was 6.1% (95% confidence interval, CI: 4.74–7.92) versus 15.1% (95% CI: 7.63–28.73) in infants given replacement feeds (hazard ratio: 2.06, 1.00–4.27, $P = 0.051$),¹² despite the fact that the women opting not to breastfeed were of higher socioeconomic status. By 18 months of age, the probability of survival was not significantly different for HIV-uninfected infants, whether they were breastfed or formula-fed from birth, despite these mothers and infants receiving excellent support to make and practice appropriate infant feeding choices.¹³ Therefore, as in the MASHI study, the avoidance of breastfeeding incurred no survival gain for these infants.

A small study in South Africa that assessed contamination of milk bottles at clinics and in the home found high levels of contamination with faecal bacteria (67% of clinic samples and 81% of home samples). The study also found evidence of poor formula preparation with over-dilution occurring among 28% of clinic samples and 47% of home samples.¹⁴ In Botswana and South Africa, the supply of formula through public health facilities is

frequently unreliable.^{10, 15}

The South African PMTCT guidelines recommend that every antenatal visit include counselling on infant feeding (Box 1), yet several studies in South Africa have found that the quality of this counselling is poor^{16–18} and that AFASS conditions are not taken into account.³ In the context of weak counselling and unclear messages, availability of free formula provides an incentive to choose this option, even when it is not appropriate, since free formula might be viewed as a cash transfer to poor households.

The provision of free commercial infant formula through the public health system may also reinforce the common practice of mixed feeding in the general population, i.e. among HIV-negative women.¹⁹ Data from the Good Start cohort study in South Africa show that formula use among HIV-negative women was significantly higher than formula use among breastfeeding HIV-positive women at all measured time points.²⁰ Key principle 7 in the WHO *Guidelines on HIV and infant feeding 2010* states that counselling and support to mothers known to be HIV-infected, and health messaging to the general population, should be carefully delivered so as not to undermine optimal breastfeeding practices among the general population.²¹

Cost of feeding options

A recent analysis undertaken for WHO for southern African countries found that the cost per 10 000 HIV-positive mothers would be US\$ 522 542 with the option of breastfeeding plus maternal HAART for women with a CD4 count \leq 350 or breastfeeding with infant nevirapine prophylaxis for women with a CD4 count $>$ 350. In comparison it would cost US\$ 2 063 100 per 10 000 HIV-positive mothers provided with maternal HAART and 6 months of formula milk for women with a CD4 count \leq 350 or for 6 months of formula milk for women with a CD4 count $>$ 350.²¹ The study concluded that “any feeding strategy that includes free provision of infant formula to HIV-infected mothers, even for a limited period of 6 months, is between two and six times more costly than a strategy that provides ARVs as prophylaxis to reduce postnatal transmission. The costing model took a conservative approach to the cost of providing infant formula with likely underestimates of staff time required to dispense and counsel on formula feeds and the storage costs of tins of formula milk.”²¹ Furthermore, the costing did not include nutritional support to breastfeeding mothers to provide mothers with the extra nutrients needed for breastfeeding.^{22, 23}

A new addition in the recently released South African PMTCT clinical guidelines¹ is the provision of nutritional support to HIV-positive mothers. However this support is due to be given to both breastfeeding HIV-positive mothers and formula-feeding mothers with food insecurity (Box 1). It is not clear from the guidelines how food insecurity among formula-feeding mothers will be determined but this option is by far the most expensive (provision of free formula and nutritional support) and is likely to be taken up inappropriately without very clear implementation plans.

More harm than good?

There are encouraging new data that ARV regimens, when given as prophylaxis to the infant, can reduce post-natal HIV transmission to around 5% at 9 months.^{24, 25} Mothers who receive effective ARVs also appear to be at low risk of HIV transmission, with studies reporting transmission rates of around 5% at 12 months postpartum.^{26, 27} When ARVs are given to infants as prophylaxis during breastfeeding or as HAART to mothers, the risk of excess mortality from non-HIV causes among uninfected children takes on greater significance, because even small elevations can counteract the now-reduced HIV transmission risk.

In light of the above, and the new clinical PMTCT guidelines in South Africa, an important consideration for the national government is whether the reduction in HIV transmission through avoidance of breastfeeding outweighs the accompanying risks from infectious disease mortality. The latest evidence suggests that, in the context of HAART provision for HIV-positive women or ARV prophylaxis to breastfeeding infants, avoidance of breastfeeding leads to worse outcomes. In the MASHI study in Botswana the combined outcome of HIV-uninfected child deaths or HIV transmission from birth to 6 months was approximately half in the breastfed plus ARVs group compared with the formula-fed group.²⁸

One feeding strategy

The thrust of the new WHO guidelines for HIV and infant feeding is that countries should choose one infant-feeding strategy that health services can advise for HIV-positive mothers. In South Africa, exclusive breastfeeding with ARV interventions is an appropriate option since, with its socio-demographic pattern and urban–rural inequities, the majority of the population would not meet the new WHO AFASS criteria for formula feeding.² The recent South African Demographic and Health Survey found that access to piped water into a dwelling was 58% for urban residents and 11% for rural residents, 87% of urban residents and 56% of rural residents used electricity for cooking and 74% of urban residents and 5% of rural residents had a flush toilet.²⁹

In South Africa, improving exclusive breastfeeding practices is a major challenge as we have one of the lowest rates in the world. The most recent Demographic and Health Survey found that only 8% of infants aged less than 6 months were exclusively breastfed.²⁹ The reasons for this low rate are complex but almost certainly include longstanding cultural practices, the support of formula milk through the government protein-energy malnutrition scheme,³⁰ the lack of promotion of breastfeeding due to high HIV prevalence and the provision of free formula milk through the PMTCT programme. Although the recent Human Sciences Research Council national survey report quotes higher exclusive breastfeeding rates (25%), the validity of this data is questionable due to the long recall period and the lack of in-depth feeding questions.¹⁹

The current policy of presenting HIV-positive women with two “equivalent”

options is likely to have contributed to the confusion among both mothers and health workers.³¹ Furthermore, the latest evidence presented here establishes that the two options are not equivalent with regard to HIV-free survival of infants. Moving to one fully-supported policy of exclusive breastfeeding will therefore help to reduce confusion and lead to the greatest child survival benefit for the total child population, the majority of whom are not exposed to HIV.

Recommendations

In light of the recent WHO guidelines on HIV and infant feeding,²¹ we urge the South African government to decide upon one single infant-feeding practice that will be promoted and supported in general and in particular among HIV-positive women attending public health facilities. The data presented in this paper and in the recent WHO principles and recommendations²¹ support exclusive breastfeeding with ARV prophylaxis. The government should subsequently embark on a gradual process of withdrawing the provision of free infant formula milk as part of the PMTCT programme. This approach does not imply that exclusive breastfeeding is necessarily the most appropriate feeding option for all HIV-positive women in South Africa, given the vast differences in socio-economic status between populations, rural and urban areas and provinces. However, exclusive breastfeeding is an important child-survival strategy in South Africa even among HIV-positive women.

There is still a role for individualized counselling and clear guidelines should be provided on how to identify those women who could avoid breastfeeding. The latest WHO principles and recommendations on HIV and infant feeding²¹ define very specifically what is meant by AFASS using common everyday language and outlining six conditions that should be met to make an appropriate decision to formula feed. In these cases, women should be given the choice to purchase formula supplies for their infant, thus eliminating any perverse incentives from within the health services.

A process of formula withdrawal would need to be phased-in and should be accompanied by a vigorous and clear literacy campaign to inform health workers and mothers of the changes in the policy and the reasons and benefits thereof. This will reduce the possibility for further confusion and mixed messages. A similar process was undertaken by the United Nations Children's Fund (UNICEF) in 2002 when a decision was made to withdraw the provision of free formula milk to UNICEF-supported PMTCT pilot sites across Africa.³² In some countries, distribution of free formula continued for a further year to avoid abrupt cessation of milk supply to those children already in the programme.³²

A technical group should be convened to work together with the Department of Health to develop a plan for withdrawal of free commercial infant formula, together with a high-level intensive plan to increase rates of exclusive breastfeeding, and to refine strategies or tools that could be used to identify the few women who may "opt out" of breastfeeding. This group needs to monitor the effect of this policy, especially the effect of opting out

of breastfeeding, on long-term survival and morbidity in mothers and infants.

Conclusion

The revised South African clinical PMTCT guidelines provide an opportunity to rapidly reduce postnatal HIV transmission by providing ARVs for women who need them and for infants during breastfeeding. Urgent action is needed so that exclusive breastfeeding with ARV prophylaxis is presented as the default feeding option to HIV-positive women. Clear guidelines must be developed to identify those women who are an exception to this default option. The provision of free commercial infant formula milk should be phased out after community-based advocacy activities so that it does not remain a perverse incentive that could negate the child survival gains of the new guidelines. An opportunity is now presented to move beyond a focus on HIV prevention to a focus on child survival through vigorously promoting the practice of exclusive breastfeeding.

Competing interests:

None declared

References

1. National Department of Health South Africa and South African National AIDS Council. *Clinical guidelines: PMTCT (prevention of mother-to-child transmission of HIV)*. Pretoria: National Department of Health; 2010.
2. *HIV and infant feeding: revised principles and recommendations*. Geneva: World Health Organization; 2009.
3. Doherty T, Chopra M, Jackson D, Goga A, Colvin M, Persson LA. Effectiveness of the WHO/UNICEF guidelines on infant feeding for HIV-positive women: results from a prospective cohort study in South Africa. *AIDS* 2007; 21: 1791-7 doi: [10.1097/QAD.0b013e32827b1462](https://doi.org/10.1097/QAD.0b013e32827b1462) pmid: [17690578](https://pubmed.ncbi.nlm.nih.gov/17690578/).
4. Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS. How many child deaths can we prevent this year? *Lancet* 2003; 362: 65-71 doi: [10.1016/S0140-6736\(03\)13811-1](https://doi.org/10.1016/S0140-6736(03)13811-1) pmid: [12853204](https://pubmed.ncbi.nlm.nih.gov/12853204/).
5. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? *Lancet* 2003; 361: 2226-34 doi: [10.1016/S0140-6736\(03\)13779-8](https://doi.org/10.1016/S0140-6736(03)13779-8) pmid: [12842379](https://pubmed.ncbi.nlm.nih.gov/12842379/).
6. Bradshaw D, Chopra M, Kerber K, Lawn JE, Bamford L, Moodley J, et al., et al. Every death counts: use of mortality audit data for decision making to save the lives of mothers, babies, and children in South Africa. *Lancet* 2008; 371: 1294-304 doi: [10.1016/S0140-6736\(08\)60564-4](https://doi.org/10.1016/S0140-6736(08)60564-4) pmid: [18406864](https://pubmed.ncbi.nlm.nih.gov/18406864/).
7. Lockman S, Smeaton LM, Shapiro RL. Morbidity and mortality among infants born to HIV-infected mothers and randomised to breastfeeding versus formula feeding in Botswana (MASHI Study). In: *International AIDS Conference, Toronto, 13-18 August 2006*.
8. Obimbo EM, Mbori-Ngacha DA, Ochieng JO, Richardson BA, Otieno PA, Bosire R, et al., et al. Predictors of early mortality in a cohort of human immunodeficiency virus type 1-infected African children. *Pediatr Infect Dis J* 2004; 23: 536-43 doi: [10.1097/01.inf.0000129692.42964.30](https://doi.org/10.1097/01.inf.0000129692.42964.30) pmid: [15194835](https://pubmed.ncbi.nlm.nih.gov/15194835/).
9. Mbori-Ngacha D, Nduati R, John G, Reilly M, Richardson B, Mwatha A, et al., et al. Morbidity and mortality in breastfed and formula-fed

- infants of HIV-1-infected women: a randomized clinical trial. *JAMA* 2001; 286: 2413-20 doi: [10.1001/jama.286.19.2413](https://doi.org/10.1001/jama.286.19.2413) pmid: [11712936](https://pubmed.ncbi.nlm.nih.gov/11712936/).
10. Creek TL, Kim A, Lu L, Bowen A, Masunge J, Arvelo W, et al., et al. Hospitalization and mortality among primarily non-breastfed children during a large outbreak of diarrhea and malnutrition in Botswana, 2006. *J Acquir Immune Defic Syndr* 2010; 53: 14-9 doi: [10.1097/QAI.0b013e3181bdf676](https://doi.org/10.1097/QAI.0b013e3181bdf676) pmid: [19801943](https://pubmed.ncbi.nlm.nih.gov/19801943/).
 11. Taha T, Nour S, Li Q, Kumwenda N, Kafulafula G, Nkhoma C, et al., et al. The effect of human immunodeficiency virus and breastfeeding on the nutritional status of African children. *Pediatr Infect Dis J* 2010; 29: 514-8 pmid: [20054287](https://pubmed.ncbi.nlm.nih.gov/20054287/).
 12. Coovadia HM, Rollins NC, Bland RM, Little K, Coutsooudis A, Bennish ML, et al., et al. Mother-to-child transmission of HIV-1 infection during exclusive breastfeeding in the first 6 months of life: an intervention cohort study. *Lancet* 2007; 369: 1107-16 doi: [10.1016/S0140-6736\(07\)60283-9](https://doi.org/10.1016/S0140-6736(07)60283-9) pmid: [17398310](https://pubmed.ncbi.nlm.nih.gov/17398310/).
 13. Rollins NC, Becquet R, Bland RM, Coutsooudis A, Coovadia HM, Newell ML. Infant feeding, HIV transmission and mortality at 18 months: the need for appropriate choices by mothers and prioritization within programmes. *AIDS* 2008; 22: 2349-57 doi: [10.1097/QAD.0b013e328312c740](https://doi.org/10.1097/QAD.0b013e328312c740) pmid: [18981775](https://pubmed.ncbi.nlm.nih.gov/18981775/).
 14. Andresen E, Rollins NC, Sturm AW, Conana N, Greiner T. Bacterial contamination and over-dilution of commercial infant formula prepared by HIV-infected mothers in a prevention of mother-to-child transmission (PMTCT) programme, South Africa. *J Trop Pediatr* 2007; 53: 409-14 doi: [10.1093/tropej/fmm059](https://doi.org/10.1093/tropej/fmm059) pmid: [18063653](https://pubmed.ncbi.nlm.nih.gov/18063653/).
 15. Goga AE, Van Wyk B, Doherty T, Colvin M, Jackson DJ, Chopra M. Operational effectiveness of guidelines on complete breast-feeding cessation to reduce mother-to-child transmission of HIV: results from a prospective observational cohort study at routine prevention of mother-to-child transmission sites, South Africa. *J Acquir Immune Defic Syndr* 2009; 50: 521-8 doi: [10.1097/QAI.0b013e3181990620](https://doi.org/10.1097/QAI.0b013e3181990620) pmid: [19408359](https://pubmed.ncbi.nlm.nih.gov/19408359/).
 16. Sibeko L, Coutsooudis A, Nzuzza S, Gray-Donald K. Mothers' infant feeding experiences: constraints and supports for optimal feeding in an HIV-impacted urban community in South Africa. *Public Health Nutr* 2009; 12: 1983-90 doi: [10.1017/S1368980009005199](https://doi.org/10.1017/S1368980009005199) pmid: [19323863](https://pubmed.ncbi.nlm.nih.gov/19323863/).
 17. Chopra M, Doherty T, Jackson D, Ashworth A. Preventing HIV transmission to children: quality of counselling of mothers in South Africa. *Acta Paediatr* 2005; 94: 357-63 doi: [10.1111/j.1651-2227.2005.tb03080.x](https://doi.org/10.1111/j.1651-2227.2005.tb03080.x) pmid: [16028656](https://pubmed.ncbi.nlm.nih.gov/16028656/).
 18. Buskens I, Jaffe A. Demotivating infant feeding counselling encounters in southern Africa: do counsellors need more or different training? *AIDS Care* 2008; 20: 337-45 doi: [10.1080/09540120701660346](https://doi.org/10.1080/09540120701660346) pmid: [18351482](https://pubmed.ncbi.nlm.nih.gov/18351482/).
 19. *South African national HIV prevalence, incidence, behaviour and communication survey, 2008*. Cape Town: Human Sciences Research Council; 2010.
 20. Goga A, Colvin M, Doherty T, Jackson D, Sanders D, Chopra M, et al. *Poor feeding practices at routine PMTCT sites, but more exclusive feeding amongst HIV-positive women compared with negative women*. Pretoria: Medical Research Council; 2010.
 21. *Summary of evidence for the revised WHO principles and recommendations on HIV and infant feeding*. Geneva: World Health Organization; 2010.
 22. González-Cossío T, Habicht JP, Rasmussen KM, Delgado HL. Impact of food supplementation during lactation on infant breast-milk intake and on the proportion of infants exclusively breast-fed. *J Nutr* 1998;

- 128: 1692-702 pmid: [9772138](#).
23. Dewey KG. Energy and protein requirements during lactation. *Annu Rev Nutr* 1997; 17: 19-36 doi: [10.1146/annurev.nutr.17.1.19](#) pmid: [9240917](#).
 24. Bedri A, Gudetta B, Isehak A, Kumbi S, Lulseged S, Mengistu Y, et al., et al. Extended-dose nevirapine to 6 weeks of age for infants to prevent HIV transmission via breastfeeding in Ethiopia, India, and Uganda: an analysis of three randomised controlled trials. *Lancet* 2008; 372: 300-13 doi: [10.1016/S0140-6736\(08\)61114-9](#) pmid: [18657709](#).
 25. Kumwenda NI, Hoover DR, Mofenson LM, Thigpen MC, Kafulafula G, Li Q, et al., et al. Extended antiretroviral prophylaxis to reduce breast-milk HIV-1 transmission. *N Engl J Med* 2008; 359: 119-29 doi: [10.1056/NEJMoa0801941](#) pmid: [18525035](#).
 26. Tonwe-Gold B, Ekouevi DK, Viho I, Amani-Bosse C, Toure S, Coffie PA, et al., et al. Antiretroviral treatment and prevention of peripartum and postnatal HIV transmission in West Africa: evaluation of a two-tiered approach. *PLoS Med* 2007; 4: e257- doi: [10.1371/journal.pmed.0040257](#) pmid: [17713983](#).
 27. de Vincenzi I, Kesho Bora Study Group. Triple-antiretroviral (ARV) prophylaxis during pregnancy and breastfeeding compared to short-ARV prophylaxis to prevent mother-to-child transmission of HIV-1 (MTCT): the Kesho Bora randomized controlled clinical trial in five sites in Burkina Faso, Kenya. In: *5th International AIDS Society Conference on HIV Pathogenesis, Treatment and Prevention, Cape Town, 19-22 July 2009*.
 28. Thior I, Lockman S, Smeaton LM, Shapiro RL, Wester C, Heymann SJ, et al., et al. Breastfeeding plus infant zidovudine prophylaxis for 6 months vs formula feeding plus infant zidovudine for 1 month to reduce mother-to-child HIV transmission in Botswana: a randomized trial: the Mashi Study. *JAMA* 2006; 296: 794-805 doi: [10.1001/jama.296.7.794](#) pmid: [16905785](#).
 29. *South Africa Demographic and Health Survey 2003: full report*. Pretoria: National Department of Health; 2004.
 30. Malek A. An evaluation of the protein energy malnutrition (PEM) food scheme for children aged 0 to 5 years in Mitchell's Plain, Western Cape, South Africa. *South Afr J Nutr* 1997; 87: 1242-.
 31. Tint K, Doherty T, Nkonki L, Witten C, Chopra M. *An evaluation of PMTCT and infant feeding training in seven provinces of South Africa*. Durban: Health Systems Trust; 2003.
 32. *Linkages: a review of UNICEF experience with the distribution of free infant formula for infants of HIV infected mothers in Africa*. Washington: Academy for Educational Development; 2004.